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PALÆOZOIC OUTLIERS

IN THE

OTTAWA RIVER BASIN

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EllsVIII.—*Palaeozoic Outliers in the Ottawa River Basin.*

By R. W. ELLS, LL.D.

(Read May 21, 1896.)

The presence of fossiliferous sediments at various points throughout the valley of the Ottawa has been known for many years, and some of these have been described in considerable detail in the earlier reports of the Geological Survey. Important and extensive collections of the contained fossils have been made from time to time, both by officers of the Survey and by others interested in the subject, and the horizon of most of these outliers has thus been ascertained. No regularly arranged tables of these fossils have, however, hitherto been made and published.¹

The formations recognized embrace the whole range of the Cambro-Silurian (Ordovician) system from the Potsdam sandstone to the Lorraine shales, both inclusive, while certain areas of newer strata, found at widely separated points, show that the Medina and Niagara formations of the Upper Silurian are also represented.

The basin of the Ottawa River, as determined by its tributaries, is extensive, the drainage area probably comprising not far from 130,000 square miles. The Ottawa itself follows a somewhat peculiar course, the upper part for nearly three hundred miles flowing westward from its source near the upper waters of the Gatineau, one of its principal tributaries from the north, to the head of Lake Temiscaming, while the lower portion flows in a nearly opposite or southeasterly direction to its junction with the St. Lawrence, a distance in a direct line from the head of Temiscaming Lake of about four hundred and fifty miles.

The height of land which separates the drainage basin of the Ottawa from that of James Bay is found a short distance to the north of the upper stretch of the river. That part of the basin between the main or lower portion of the Ottawa and the northern divide is occupied for the most part, in so far at least as is now known, by crystalline rocks comprising limestones, gneisses, granites, etc., of Archæan age, which have always been regarded as belonging to the Laurentian system. To the north of Ottawa city the height of land is about two hundred and thirty miles distant, and the eastern limit of the drainage area is marked by the River du Nord, which after a somewhat irregular course to the northwest of Montreal enters the Ottawa River about thirty miles west of its junction with the St. Lawrence. To the west of Lake Temiscaming, the line dividing the Ottawa waters from those of Lake Huron on the

¹ The publication of these lists is for the present deferred, owing to the large amount of material therein contained. They will, however, shortly appear in the report of the Geological Survey on the areas adjacent to the Ottawa River.

south and James Bay on the north, is determined by the Montreal River and its tributaries, while from the head waters of this stream the height of land extends southeasterly in an irregularly curving line to the eastern end of Lake Nipissing.

To the south of the Ottawa, the St. Lawrence water-shed, for nearly one hundred miles, keeps very close to the latter river, and in the vicinity of Prescott and Brockville it is scarcely more than three to four miles distant. Thence it curves northwesterly to the head of the Rideau chain of lakes in Bedford township, continuing northward through the centre of the county of Addington, and the northern portions of Hastings and Haliburton, and separating the waters of the Madawaska and Petawawa rivers on the north from those of the Muskoka on the south, continues on to meet that already described as reaching the east shore of Lake Nipissing from the Montreal River basin.

The area to the north and south of the Ottawa is well watered, abounding in lakes, often of large size, with many tributary streams, so that the country is comparatively easy of access by canoes throughout the greater part of its extent. Much of this area, especially to the south, has long been opened up for settlement, the soil where underlain by the Palaeozoic formation being of very superior quality. The area to the north, being more rugged, has been settled principally along the valleys of its principal streams.

North of the Ottawa the principal affluents are the Kippewa, Du Moine, Black, Coulange and Gatineau, with its many branches, some of which have their source in lake expansions of great extent, in the vicinity of the upper stretch of the river, and the Lièvre, Nation, Rouge and du Nord. To the west and south the Montreal, Mattawa, Petawawa, Madawaska, Bonnechère, Mississippi, Rideau and South Nation also drain a large expanse of country. Over this southern area the greater part also is occupied by the crystalline rocks of Laurentian and Huronian age, the Palaeozoic areas apparently filling deeply eroded basins in these underlying rocks.

While much of the country, on both sides of the Ottawa, is greatly broken by mountain masses or strongly pronounced hill features, very large tracts, more particularly as we recede from the river itself, become comparatively level, presenting the aspect of great sandy plains, out of which hills of granitic and gneissic rock rise to considerable elevations. So marked is this feature of sand distribution, with its underlying bluish-gray clay, that one naturally infers the presence of water at some time, over the greater portion of the entire area, probably to the height of land itself. This sandy character is probably best seen on the several tributaries of the Ottawa from the north as well as along much of the Ottawa itself for nearly a hundred miles below its junction with the Mattawa, where for many miles the country is covered with a great thickness of

sand, supporting at present a growth of small pine. As for much of the underlying clay its origin is doubtful. Shells are found only at rare intervals, but in character the sediments strongly resemble the marine clays of the lower Ottawa. Organic remains have, however, been found at widely separated points in the valley, up to elevations of over four hundred and fifty feet above sea level. The overlying deposits of sand and gravel are frequently well stratified, and excellent sections of these, as well as of the underlying clays, are presented along many of the streams which have cut deep channels in the drift. In these *Saxicava* and other forms are found.

While there are no exact determinations as to the altitude of the height of land north of the Ottawa, several close approximations have been obtained by means of barometric observations. The elevation of the Iroquois Chute (Labelle), on the Rouge River, has been fixed by the survey of the railway from St. Jerome at 875 feet on the terrace level one hundred feet above the river, though the elevation of the ridge east of St. Faustin, which the railway crosses, is 1,520 feet. The elevation of the height of land to the northeast between the head waters of the Rouge and the head of the Mattawin, a branch of the St. Maurice, will not probably exceed three hundred feet more, as we enter upon a broad extent of plain sandy country beyond the bend of the river near the Nominique Lake and Creek, so that the height of land in this direction would not be far from 1,050 to 1,100 feet. Further west, near the sources of the Gatineau and upper Ottawa, the height of land has been estimated, by Dr. Bell, at about the same figure, the elevation of Grand Lake being put at about 860 feet. From observations by A. E. Barlow, the height of the Abittibi divide, north of Lake Temiscaming, is put at 923 feet, while that at the head of Montreal River is not far from 1,300 feet, the elevation of Lake Temiscaming being only 585 feet. Continuing round by the south the height of the divide at Lake Nipissing is only 642 feet, but this gradually rises till, at the head waters of the Muskoka and Petawawa, it is, according to Murray, about 1,400 feet. Near the source of the Madawaska River at Papineau Lake, the same authority gives the elevation at 1,121 feet. Murray also places the source of the Little Madawaska at 860 feet, and of Wahsuhze Lake at the head of the Maganetawan at 1,097. Further east the height of the divide at the head of the Rideau lakes, according to the Canal survey, has sunk to 417 feet.

The principal area of fossiliferous sediments in the Ottawa valley, is that which extends up the lower part of the Ottawa River from its junction with the St. Lawrence and is continuous with the great area which occupies the valley of the St. Lawrence for hundreds of square miles. Prior to the deposition of these sediments a deep depression must have extended northwestward from that river for many miles and the drainage basin of the Ottawa, even at that early time, was well established. The

sedimentary deposits along the north side of the lower Ottawa at present form a narrow margin along the stream which is continuous almost to the Chats Falls, nearly one hundred and fifty miles from its mouth. The area is bounded by ranges of hills which rise a short distance back from the river; but to the south of the Ottawa the country is largely a level plain, and the sedimentary formations spread over a very considerable extent, whose western limit may be roughly bounded by a line drawn from Arnprior, forty miles west of Ottawa city, to Brockville, on the St. Lawrence, about one hundred and twenty-five miles west of Montreal. Several small outcrops of the underlying crystalline rocks appear, however, from beneath these generally horizontal strata.

The basal beds of this great series of fossiliferous sediments are frequently composed of the debris of the Laurentian gneiss and limestone, upon which these arkose strata rest, and these constitute the lowest member of the Potsdam sandstone which is now regarded as the base of the Calcareous formation. The whole series along the lower Ottawa is of special interest from the geological and paleontological standpoint, from the fact that we have here, in unaltered form and undisturbed, a complete series of strata which may be regarded as furnishing a typical section of the Cambro-Silurian system from the very bottom to the overlying Silurian. While, however, several sections are found which enable us to measure the thicknesses of the various formations, this thickness is found to vary somewhat in different portions of the area; and though the strata, as a whole, are comparatively horizontal in attitude they are at many points affected by local faults, some of which are of considerable extent, so that the problem of the determination of the entire thickness is thereby somewhat complicated.

In addition to the Cambro-Silurian formations which occur in this area, we find to the southeast of Ottawa city, in Osgoode and Russell townships, several outcrops of a reddish sandy shale, precisely similar to what have been described as occurring in the area east of the St. Lawrence, between Montreal and Quebec, and which have there been regarded as belonging to the Medina. Like the St. Lawrence outliers these newer red beds also appear to rest unconformably upon the Lorraine or Utica shales, while in the western part of the basin, on Lake Temiscaming, the geological section is still further extended upward by the presence of several outliers of Silurian fossiliferous strata which represent the Niagara formation. It will thus be seen that the fossiliferous sediments of the old Ottawa basin have a very wide range, and that this area affords especially good facilities for the study of these early sedimentary strata.

The Potsdam sandstone is readily recognized by its peculiar physical features wherever it occurs. It fills up depressions in the underlying crystalline rocks, is uniformly siliceous in composition and varies in colour from a gray to a deep red, the latter tint being apparently due to the

presence of a considerable percentage of iron (hematite) in its composition. Its observed thickness, on the Ottawa, is no where more than fifty to sixty feet and in places is much less. In the upper stretches of the river it is entirely wanting, the upper formations such as Calciferous, Chazy or Trenton resting upon the Laurentian. In the development of the Potsdam sandstone and the Calciferous formations, as studied at many points, no line of separation is possible, the one passing into the other by insensible gradations through the addition of calcareous matter to the siliceous beds of the lower member.

The typical Potsdam sandstone has not yet been recognized in the Ottawa River basin, much beyond the township of March or about twenty miles west of Ottawa city. At the Chats Falls and further west along the shore of the Chats Lake between Arnprior and the mouth of the Bonnechère, the Calciferous forms the lowest member of the series and fills up the inequalities in the Archaean floor. It is succeeded directly by the greenish-gray shales and sandstones of the Chazy which pass upward by the development of calcareous bands into the upper or calcareous portion of that formation. The line of the Chats Falls, properly speaking, marks the western limit of the great lower Ottawa basin, though the sedimentary beds further west, around the lower part of the Chats Lake, were probably at one time continuous. There is, however, a marked break in the levels of the deposition of the Calciferous below and above the falls; the Chats Lake beds being at a considerably higher level than those below.

The great lower Ottawa basin is affected by several low undulations, though the inclination of the strata is at a low angle throughout the area. The lowest or Potsdam sandstone member is very regularly exposed along the western or Ontario margin, the highest members, viz., the Lorraine shales and the overlying Medina, being found nearer the northwestern angle of the basin but a short distance to the south and east of Ottawa city.

Between the Calciferous and the Chazy a somewhat well defined change in the character of the strata is visible at various points. Thus the entire series of the former consists of limestones, somewhat siliceous, but generally highly dolomitic, with a well defined fauna. Occasionally somewhat thin arenaceous but dolomitic shales appear in the upper portion. A peculiar feature of the limestone, and one by which the formation can be readily recognized, is the presence of geodes, holding yellowish-white calc-spar, though sometimes with quartz crystals or gypsum. This peculiarity is seen in the dolomites, from the most westerly outcrop on Allumette Island in the Ottawa, as well as in the beds east of the St. Lawrence; and as a whole the strata composing this formation present a marked uniformity in texture and composition throughout their whole extent.

The second formation, viz., the Chazy, is separable into two portions, the lower of which is a shaly and sandy series, while the upper is largely calcareous. East of Ottawa, the lowest members can be well studied along the Grenville and Carillon Canal, while the upper portion is well developed in the area to the south. Excellent sections are also exposed in the vicinity of Ottawa city and along the shores of the Ottawa River at Aylmer, and on the southern bank in the townships of March and Fitzroy.

The lowest beds of the Chazy at these places consist of a somewhat coarse greenish-gray grit or sandstone in places conglomeratic in character, and in general aspect not unlike some of the gritty beds of the Sillery formation. These have a thickness of only a few feet and they graduate upwards into finer arenaceous beds of a light greenish-gray shade, with a considerable thickness of shales. Certain bands in this portion contain fossils and are fucoidal. Intercalated beds of limestone appear in the upper part, which gradually becomes more calcareous till the formation is essentially a limestone. At Aylmer the thickness of the lower portions of the Chazy, to the base of the limestones proper, is apparently not far from one hundred to one hundred and twenty feet.

The thickness of the upper or calcareous portion varies greatly at different places, ranging from fifty to nearly one hundred feet. In its upper part the limestones become nodular, and certain beds of grayish colour are largely composed of *Rhynchonella plena*.

The passage from the upper beds of the Chazy to the overlying beds of the Bird's Eye and Black River, which lie between those just described and the main mass of the Trenton formation, appears to be gradual and to present no well defined break in the succession of the strata. The Black River, which in Canada includes the Bird's Eye in its lower portion, consists of certain dark brown and black limestones often cherty, breaking with a marked conchoidal fracture, and distinguished largely by the presence of *Tetradium fibratum*, which is in places so abundant as to constitute almost the entire mass of some of the beds. Certain other fossil forms, such as *Columnaria Halli* and *Orthoceras Bigsbyi* are particularly developed in the strata of this formation but from the difficulty of clearly distinguishing these limestones as a group from the Trenton at many places, they are now generally included in the latter formation. The thickness of the Bird's Eye and Black River is given in the *Geology of Canada*¹ as only thirty-eight feet for the area in the lower Ottawa basin, near Montreal, but on the upper Ottawa, as at Eganville, Douglas, etc., this is increased to over one hundred feet.

The Trenton is essentially a limestone formation throughout. The lower portion consists largely of grayish and black, often bituminous beds, holding an abundance of fossils, among which *Stenopora fibrosa* is very abundant; the upper 350 to 400 feet are for the most part dark

¹ *Geology of Canada*, 1863, p. 137.

coloured, bituminous and compact, with partings of dark brown or black argillaceous shale. This formation is particularly rich in organic remains, both of corals, shells and trilobites, and the area between the Ottawa and St. Lawrence, occupied by it, is estimated at over 600 square miles. The total thickness of this formation as developed in the lower Ottawa basin is not far from 650 to 700 feet.

The Utica and Hudson River (Lorraine) formations constitute the upper members of the Cambro-Silurian system. While having their greatest development in the St. Lawrence valley, they also appear at several points in the Ottawa basin. The rocks of the lower division, or the Utica, are usually black brittle bituminous shales with thin bands of yellow-weathering limestone. The formation is thus lithologically distinct from the underlying Trenton. The thickness as given in the typical section at the Montmorency Falls, below Quebec, is 318 feet, but this thickness must be greatly reduced for the deposits in the Ottawa basin where it will probably not reach one hundred feet. There is no defined break between the strata of the Utica and those of the Lorraine, the passage being apparently continuous, through the replacement of the dark bituminous beds by grayish shales and sandstones and by an almost entire disappearance of calcareous matter. The thickness of the upper division is placed at 719 feet in the St. Lawrence section, but as in the case of the Utica this must be also very largely reduced for the western area. The only known outlier of the Lorraine to the southeast of Ottawa is represented by a very thin series of beds, probably not more than thirty or forty feet in so far as yet observed.

The formations just described for the lower Ottawa area complete the Cambro-Silurian series; but as already intimated, in the townships of Osgoode and Russell, certain reddish shales and sandstones¹ occur which overlie the Lorraine, and presumably represent the Medina division of the Silurian. No fossils have yet been found in these newest outliers; and owing to the great mantle of drift with which they are surrounded, and for the most part concealed, their thickness cannot be ascertained.

In order to complete the series of Palaeozoic formations which occur in the area now being discussed we may here refer to the peculiar outlier of Niagara rocks which occurs near the upper end of Lake Temiscaming. A description of these is given in the *Geology of Canada*, 1863, from which we learn that the formation lies unconformably upon the sandstones (quartzites) of the Huronian of that district. The lower part of the outlier is generally arenaceous, and very often a conglomerate, containing large boulders of the underlying rock. Mr. A. E. Barlow, who has recently studied these rocks, describes them as occurring on both sides of the lake as well as on Chief's Island and on several smaller islands near by. The base of the deposits is said to "consist of vast boulders and

¹ *Geology of Canada*, 1863, p. 219.

fragments of the underlying sandstone, in a calcareo-arenaceous fossiliferous matrix ; some of the inclosed masses being nine feet in diameter. Near by are seen the Huronian sandstone strata, great cracks and worn fissures which are filled with the fossiliferous cement."¹

The limestones which make up the bulk of this outlier are mostly buff or cream-coloured with thin interstratified shales. Some of the beds are hard and cherty, resembling lithographic stone, and the whole series contains an abundance of corals with other fossils which clearly indicate their horizon.

The thickness as exposed in the sections is stated to be about one hundred and fifty feet, and this is probably increased by the series of beds near the centre of the deposit, so that the whole thickness is estimated by Mr. Barlow as not more than three hundred feet.

In regard to the several fossiliferous outliers which occur at often widely separated points throughout the basin of the Ottawa, it may be said that in none of these can the same succession of formations as we have just described be observed. Some are represented by but one, the others having been presumably removed by denudation of the overlying strata.

On the north side of the Ottawa River, with the exception of the small fringe which is found between the Laurentian hills and the river itself, only two, or at most three, distinct areas of small size have yet been recognized. The most easterly of these is the small outlier of Calciferous strata lying to the east of the North River about seven miles northwest of St. Jerome to the north of Montreal, where characteristic fossils of this formation are found. Further west at the village of Lachute, a hill of Potsdam sandstone occurs just east of the village with an exposed thickness of about forty feet, and is directly overlaid by the Calciferous, which is seen in the bed of the North River at the crossing of the Canadian Pacific railway ; but these outcrops presumably represent the northern margin of the Ottawa and St. Lawrence basin. The succession of formations seen in the city of Hull and thence to Aylmer and for several miles beyond, representing rocks of Calciferous, Chazy, Black River and Trenton age, also belong to the same basin, the northern margin of which is seen in thin strata of the Calciferous and Chazy near the village of Quyon, as well as in a small margin of the former on the north side of the river near the old village of Pontiac at the foot of the Chats Falls.

The northern margin of the Arnprior and Sand Point outlier is also seen above the Chats, along the north shore of the Ottawa for several miles, as well as in several islands in the river below Bristol ; but on the roads, a mile or so east of Portage du Fort, isolated outcrops of dolomitic Calciferous strata occur which have been broken up and, in places, altered by the action of certain intrusive masses of greenstone which have cut

¹ Geology of Canada, 1863, pp. 334-36.

the underlying Laurentian limestone and associated gneiss. These outliers are small in extent covering only a few hundred square yards.

With the exception of a narrow fringe of fossiliferous strata of Calci ferous and Chazy age along the shore of Coulonge Lake, which is an expansion of the Ottawa above the village of Fort Coulonge, and well seen at Sèche Point, as well as at the point above, no other deposits of sedimentary fossiliferous rocks were observed in this area. The Potsdam sandstones have evidently not been deposited along these upper stretches of the river basin, as the Calci ferous and Chazy rest directly upon the crystalline rocks.

The largest area of the Palaeozoic strata in this direction is presumably that which occupies the greater part of Allumette Island and extends eastward across the channel of the Ottawa, comprising a very considerable portion of the township of Westmeath. The formations here represented are the Calci ferous, on the west end of the island, Chazy and Black River, the latter of which has been particularly studied at Paquette's Rapids near the junction of the south or Pembroke channel with that which continues down the north side of the island. The fossils occur in the usual dark-grayish limestone and are frequently silicified, causing them to stand out distinctly from the weathered or water worn surface of the containing rocks. The Chazy is represented by the lower greenish-gray shales and sandy beds and by the upper or limestone formations, the upper beds presenting the same nodular character as seen on the lower Ottawa.

The western edge of this outlier shows a very narrow margin of Calci ferous on the shore about four miles above the town of Pembroke, while the Chazy portion is represented in the town itself and for several miles to the southeast. The Westmeath area, which is the eastward extension of that on the island, shows but few outcrops of solid rock, the country being generally low and drift covered, but large masses of the characteristic Chazy and Black River limestone are seen at several points indicating the existence of the basin over a considerable area. The elevation of the Allumette Lake is about 370 feet above sea level which would be about the same as for the Chazy and Black River ridge at Sand Point near Arnprior.

Another area of considerable size, but apparently separated from that just described, is seen to the south of the lower end of Muskrat Lake in the townships of Stafford and Bromley. The outlier embraces nearly twenty square miles and consists of the Chazy and Black River formations only, in so far as can be determined, the latter being particularly well exposed. Like other Palaeozoic outcrops in this basin, the strata lie in a nearly or quite horizontal attitude, the inclinations observed being only from 1° to 3°, the principal area rising in a somewhat bold escarpment from the valley of the Muskrat River to a height of seventy-five or

eighty feet. The shaly beds of the Chazy do not appear in this direction, but the upper part of the plateau is occupied by the lower portion of the Trenton proper.

A somewhat extensive and important outlier is that found on the Bonnechère and extending on both sides of that stream for several miles.

To the east of Lake Doré, a ridge of a hundred feet or so in height is thickly strewn with large blocks of Black River limestone and with boulders of Laurentian gneiss, the former holding characteristic fossils of the formation. Well defined ledges, however, rarely appear, though they are found at several points, rendering it probable that they underlie the area over a very considerable extent. These massive blocks of the Black River limestone form a peculiar feature, not only here but at several widely separated points and show that the Black River formation has had a very considerable development, being probably spread in a regular sheet at about the same elevation over long distances, throughout that part of the Ottawa basin above the Chats Falls in the vicinity of Arnprior, the beds near which place would seem to mark a second stage of elevation in the deposition of this formation.

In the bed of the Bonnechère River near the village of Douglas, well defined ledges of the Chazy shales and sandstones are seen which dip at angles of 5° to 20° and these pass upward into the characteristic Chazy limestone which at the summit of the ridges to the north and south graduates into the Black River formation. What are regarded as Trenton beds are stated to occur at Jessup's Rapids about seven miles west of Douglas and not far below the town of Eganville; but as the lower Chazy occupies the bed of the stream at that place, dislocations must occur which have broken the regular succession of strata. The beds of the Black River are well exposed at this place, both along the stream and on the hills to the south, the thickness of the formation here being apparently not far from one hundred feet. Sections of the formations at these places on the Bonnechère were published by Murray in 1854.¹

The elevation of the River Bonnechère at Douglas, is given by Murray at 383 feet. The area along the stream is separated to the north by a ridge of crystalline limestone and gneiss, on which Douglas village is built, from a more extensive area which occupies a very considerable portion of the townships of Bromley and Wilberforce, and extends from the eastern side of Doré Lake for some fifteen miles in a southeast direction with an average breadth of from four to five miles. The upper beds of this outlier clearly belong to the Trenton formation, while to the south of the Bonnechère, Black River beds have a breadth of over one mile and extend for several miles eastward in a ridge along the south side of the stream. The two areas presumably connect in the flat-lying country to the east of Douglas. To the south of Eganville also an extension of the

¹ Report of Progress, 1853-56, pp. 94-98.

upper Bonnechère outliers is seen with a breadth of more than a mile resting upon the Laurentian gneiss.

Owing, however, to the very considerable extent of the drift deposits over much of this country, it is obviously very difficult to determine with accuracy the limits of these outcrops, since large areas are covered with blocks of the Black River formation, which rest presumably in many cases upon the underlying gneiss and granite.

On the line of the Ottawa, Arnprior and Parry Sound railway, about three miles west of the station of Killaloe, which is near the southwest angle of Golden Lake, a small outlier of grayish sandy-looking limestone, possibly a part of the Chazy formation, has been cut through. The exposed outcrop is only a few hundred yards in extent lying among the hills of gneiss and granite. The elevation of the spot on the railway was not ascertained, but is not far from 750 feet.

To the south of this, on the southwest portion of Clear Lake, deposits of Trenton limestone are overlaid near the shore by typical Utica shales containing fossils characteristic of that formation. The elevation of Clear Lake is 745 feet above the sea, and this is the only observed outcrop of the Utica west of the city of Ottawa. Its elevation above the lake is about one hundred feet, but on the road which extends along the mountain at a further height of 500 feet or about 1,350 feet above the sea, great quantities of large blocks of the Black River limestone are scattered about. These do not, however, represent an outlier in place, the present position of the blocks being evidently due to ice action in some form. On the Opeongo road, however, about five miles east of this place, a large outlier of the Black River formation is seen.

In the vicinity of Calabogie Lake, which has an elevation of 563 feet, outliers of Chazy and Black River rocks occur, both on the north and south side. The exposed outcrops are but small, much of the area being drift covered. Chazy blocks are also numerous on the Opeongo road about eight miles west of Renfrew, indicating a possible outlier of the formation in this direction. To the southwest of Clear Lake in the township of Lyndoch, an outlier of Silurian rock was also discovered by Dr. F. D. Adams in 1894. This is not far from the Madawaska River, but in the absence of fossils from this locality, its exact horizon cannot yet be stated.

On the upper Ottawa an interesting outlier is seen on both sides of the river, at Deux Rivières, about twenty miles below the mouth of the Mattawa. The exposure is seen along the stream for about three miles and consists for the most part of an impure limestone, which becomes more sandy in its lower portion. It is a buff gray in colour, and sufficiently siliceous to be used for grindstones. Throughout the entire thickness of the outlier orthoceratites and other fossils occur which fix its horizon as that of the Black River formation, though in lithological char-

acter the strata are quite different from those of the typical Black River of the lower Ottawa. These beds extend along the stream to L'Eveille Rapids, a distance of about three miles, and the elevation of this point is 480 feet above sea. Interesting outliers also occur on some of the islands in Lake Nipissing, at an elevation of 642 feet. These are also of Black River age, but like those last mentioned the strata differ in aspect from those of the lower Ottawa, though the contained fossils are similar.

The formations recognized in all these Palaeozoic outliers, are for the most part, highly fossiliferous, with the exception of the Potsdam sandstone. In this, as developed in the lower Ottawa basin, the principal traces of organic remains are seen in the peculiar markings known as *Scolithus*, which, on weathered surfaces, present the form of nearly cylindrical holes from the twentieth to the eighth of one inch in diameter. Some of the strata are thickly studded with these markings which penetrate the rock to a depth of several inches, sometimes in a direct course but frequently curved, and often irregularly contorted. The origin of these is, as yet, doubtful. Other peculiar markings found on the surfaces of certain beds of the sandstone have apparently been caused by the passage of some crustacean across them, of which, however, no trace has yet been found in the rock itself. These have received the name of *Protichnites*. As we approach the transition beds between the sandstones and the calcareous members of the Calceiferous, however, several well defined forms of brachiopods, gasteropods and cephalopods occur, among which species of *Lingula* and *Ophileta* are recognized. These are well seen on the southern margin of the main Ottawa basin at Beverly, in the township of Bastard, not far from the head of the chain of the Rideau lakes, and these fossils may be held to mark the lowest well defined forms of organic life yet found in the Cambro-Silurian system of the Ottawa basin and that of the St. Lawrence basin adjacent.

While the strata in all the areas described are for the most part nearly horizontal, indications of faults are clearly visible at a number of points and tend to render uncertain the calculations made to determine the thickness of the several geological divisions. Several of these can be well seen about the city of Ottawa and in the country to the west between that place and Arnprior. Along the lower Ottawa also, about Hawkesbury and L'Orignal, several breaks can be observed which affect the strata of the Chazy and Black River formations.

The presence of intrusive masses is also clearly seen at several points, among which may be mentioned the Potsdam area of Nepean, near the line of the township of March, where dykes cut the underlying Laurentian as well as the overlying Potsdam sandstone. These are particularly well seen in the cuttings of the Ottawa and Parry Sound railway; while further west near Portage du Fort the Calceiferous beds are also similarly affected.

As already intimated very considerable collections of the contained organic remains have been made at various times. These have now been determined and have been properly classified and arranged under their respective localities by Dr. H. M. Ami and by Mr. L. M. Lambe. As these lists will be of great benefit for the purpose of determining exact horizons and for assisting in the future study of these interesting outliers, a number of them have been prepared, which will shortly appear in the Geological Survey's report on this area, now in course of publication. It may be remarked, however, that the fossiliferous sediments of the extreme western portion of the basin differ very considerably from those of the typical areas as developed along the lower Ottawa in lithological character; and in this respect they approach somewhat the sediments found in the basins of Lake Ontario, Erie and Huron, where apparently somewhat different conditions of deposition have prevailed. The deposits are somewhat more sandy and dolomitic in their character, resembling the peculiar deposits of similar horizons seen in the valley of the Red River in Manitoba; so that those of the upper Ottawa apparently partake of the character of both, or are intermediate between those of the two districts, so widely separated by distance. Those of the lower Ottawa are for the most part clearly due to conditions of deep water deposition, while the western deposits are apparently more littoral in character or have been laid down in shallow waters. The evidence therefore seems fairly conclusive that over a very large portion of the Ottawa River basin the Palaeozoic formations were at one time continuous over its greater part. The subsequent denudation must, however, have been enormous, since not only has the greater part of these been removed, the evidence of such removal being readily seen in the many bold escarpments at widely separated points throughout the area, but there are also great deposits of clays, sand and gravel, which constitute a marked feature over many portions of the basin itself.